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A MANUAL

OF

ELECTRICITY:

CONTAINING

Observations on the Electrical Phenomena,

AND

DIRECTIONS FOR THE CONSTRUCTION OF

Metallic Conductors.

ALSO

FOR THE MAKING OF

Electrical Machines & Galvanic Troughs,

WITH

Instructions for applying their Influence

IN AID OF MEDICINE, AND IN RESTORING SUSPENDED ANIMATION.

BY WM. KING, MEDICAL ELECTRICIAN, AND LECTURER ON ELECTRICITY & GALVANISM.

NEWBERN, N. C.
1825.

Phys 3130.4

UNITED STATES OF AMERICA, } Office of the United
District Court,
North-Carolina District. } District of Pam

BE IT REMEMBERED, that on the ten
L. S. of February, in the forty-ninth year
Independence of the United States of An
William King of the said district, hath deposited
office, the title of a book, the right whereof he cla
proprietor, in the words following, to-wit: "A M
"of Electricity: containing Observations on the E
"cal Phenomena, and Directions for the Construct
"Metallic Conductors. Also for the Making of E
"cal Machines & Galvanic Troughs, with Instructi
"applying their Influence in aid of Medicine, and
"toring Suspended Animation."

In conformity to the Act of the Congress of the U
States, entitled "An Act for the encouragement of
ing, by securing the copies of maps, charts, and b
to the authors and proprietors of such copies duri
times therein mentioned." And also to the Act, en
"An Act supplementary to an Act, entitled 'An A
the encouragement of learning, by securing the cop
maps, charts, and books, to the authors and propr
of such copies during the times therein mentioned,
extending the benefits thereof to the arts of desig
engraving, and etching historical and other prints.

JER. BROWN, *Cl*

ERRATA.

Wherever *sixteenth* century occurs, read *seven*
century; and wherever *seventeenth* century occurs,
eighteenth century.

P. 35 17th line from the top, for "*the same matér*
read *electric materials.*

P. 35. 15th line from top, between the words "*a*
phere" and "*is,*" insert *when dry.*

P. 46. 5th line from the top, for "*connected to the*
pole," read connected to the *rod on the* ridge pole.

P. 70. for Samaratan, read Samaritan.

P. 73. 14th line, for *tenants,* read *tenons.*

PREFACE.

The author of these pages, having for a course of years occasionally given Experimental Lectures, on the science of Electricity and Galvanism, has been frequently solicited by his friends, in various parts of the Union to publish the contents of those Lectures, the substance of which, is only to be found, blended with other science, in large volumes; the expense of which, deprives the more numerous part of the community, of their benefit. To which cause, may in part be attributed, that almost universal indifference manifested by the public, with respect to the importance attached to the erection of Metallic Conductors.

He has been led to this course, with a view of gratifying his friends, and affording to the public a cheap Manual, devoted exclusively to the more useful parts of Electricity and Galvanism; particularly as it respects the erection and proper formation of Metallic Conductors for buildings.

He has also added, from his own experience, the most ready method of constructing Electrical Machines, and Galvanic Troughs; and the best method of exciting the Electric and Galvanic principle into action: and also directed, the best manner of applying their influence, as an assisting mean to the healing art.

The past season has exhibited a strong excitement of the Electric fluid, much more so, than for many years past. The author has satisfactory accounts of more than sixty human lives that have been destroyed since the first of last March, in these States, by lightning. He has also received evidence of protection, that in many instances was afforded by Metallic Conductors to buildings.

It must be well known to every considerate person, that the spires of Churches, ascending so high in the air, are exposed to the effects of Electricity much more than low objects: Therefore, those concerned in their erection, are generally induced to provide them with Conductors. There is not an instance on record, of such buildings with Conductors, being materially injured by Lightning. But there was, the last season, clear evidence of the Lightning descending by their conductors, and passing off harmless; while buildings around them were struck, and persons within them killed.

These circumstances have been a further inducement for the appearance of this Manual of the Electrical science.

In full confidence of its usefulness, it is committed to the patronage of the public, by the

AUTHOR.

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DEFINITION OF TERMS.

That the reader may not be embarrassed with words whose meaning he may not understand; I shall in the first place explain the terms used in this manual to elucidate the electrical phenomena.

ELECTRICITY

Is a term adopted by philosophers, to signify the operations of a very subtile and elastic fluid; which evidently pervades all nature, and becomes the object of our senses by lightning, and when mechanically excited by electric machines, &c. The term is derived from the Greek word Electron, and the Latin word Electrum, the English of which is amber.

ELECTRICS

Are terms to signify such bodies as shew electric appearances, by friction or rubbing, and in some instances by heating; such as receiving a power of attracting and repelling light bodies, and exhibiting sparks of light. Bodies in such a situation are said to be electrically excited; hence the term EXCITATION. These bodies are also termed NON-CONDUCTORS, because they do not freely conduct electricity over their surfaces, or through their pores.

NON-ELECTRICS

Are terms to signify such bodies as do not exhibit electric appearances by friction or heating; and they are called conductors, because they freely conduct electricity, silently, and without being seen on their surfaces.

IMPERFECT CONDUCTORS.

These terms are sometimes used, to denote such substances as conduct electricity with some considerable difficulty; exhibiting it on its passage over their surfaces.

INSULATION.

This term is used to express the situation of a body supported on any electric substance; for instance, you, or any other body, may be said to be insulated, when standing on glass, or suspended by silk, or any other electric or non-conducting substance.

Electric attraction and electric repulsion, are terms to express a certain power that electric bodies exhibit, when excited or electrified; the appearances of which are: when a body is electrified by excitation, or by its being communicated, it receives a power of drawing any light bodies towards it, and after communicating to it part of its electricity, it is then thrown off from that body. This power will receive a further explanation under the head of attraction and repulsion.

The terms *plus* and *minus*, were first used by Dr. Franklin; *plus*, to express the state of *a body* having more electricity than natu-

rally belongs to it; *minus*, expressing the state of a body having too little, or less than its natural quantity.

Positive and *negative*, are terms adopted by other philosophers, to express the same meaning as *plus* and *minus*. *Positive* for *plus*, and *negative* for *minus*.

Condensed and *rarified*, are terms adopted by some poilosophers, as more expressive of the state in which electricity appears, when excited, disturbed, or brought into action.

ELECTRIC SUBSTANCES, OR NON-CONDUCTORS, Beginning with the best.	NON ELECTRIC BODIES, OR CONDUCTORS. Beginning with the best.
The atmospheric Air, when dry,	All metals, that are in an unoxidable state,
Glass,	Charcoal,
Feathers,	Live Animals,
Amber,	Vapour or Steam.
The Diamond, and all the Precious Stones,	These bodies conduct electricity with facility, and without being seen while on their surfaces.
All Gums and Resins,	IMPERFECT CONDUCTORS.
Baked Wood,	Water,
The Oxids of all the Metals.	Green Vegetables,
Bees Wax,	Damp Air,
Sealing Wax,	Wet Wood, and all substances containing moisture,
Sulphur,	Common Wood,
Silk,	Dead Animals,
Wool,	Bone,
Hair,	Horn, &c.
Cotton, &c.	
These bodies must be dry, or they become more or less conductors.	

Electricity considered as connected in the various phenomena and operations of nature.

The influence of electricty is felt in every department of nature, throughout the animal, vegetable, and mineral kingdom. "It may be said, without much exaggeration, that whether we look to Heaven above, or to the Earth beneath, we can scarcely perceive any thing that is not acted upon, and in a manner, perfectly subjected to, the operations of this wonderful fluid. If we attend to the common phenomena of our atmosphere, experiments shew, that electricity is connected with every one of them. If we evaporate water by means of heat, a strong electricity is produced. If vapour is condensed into rain, the same phenomenon appears. If water is frozen into ice; if it descend in hail or snow, electricity appears to be equally concerned." It is manifested on a magnificent scale in a thunder storm, when "lightnings play and thunders roll," and torrents of rain descend. The coruscations of the Aurora Borealis, are probably displays of the electric light. The water spout exhibits its force: and the earthquake, that dreadful phenomenon of nature, is but a continued display of its awful and sublime powers.

This active and all pervading principle, by its attractive and repellant properties, evidently *regulates* the motions of the planetary sys-

tem, and produces that harmony of action which so forcibly discovers itself to our senses. In fact, as a very elegant writer observes, "It is the grand agent employed by Deity for the government of the universe."

What the abstract nature or essence of this extraordinary principle may be, is not fully understood; but from its wonderful properties and singular appearances, philosophers have been incited with industrious ardour to investigate its phenomena; and the result of their laborious researches has afforded us no other certain conclusion, than that its existence is universal, and its properties altogether extraordinary.

A brief History of Electricity.

Though it is certain, that electricity must have been coeval with the creation; yet the discovery of its action, and even of its existence, is, comparatively speaking, of a very late date. Thales, a Grecian philosopher, about 600 years before the Christian era, was the first that discovered the electric properties of amber. When rubbed lightly with cloth, he found that it received a power of attracting light bodies, such as down and feathers. He was so surprised with that singular property, that he supposed it possessed animation.—Were it possible for Thales to come among us, *to exhibit* the singular properties of his

piece of amber, with what surprise would he behold around him, the result of that trifling discovery! I might then refer him to the grand Electrical Machine at Harlæm, and say; go there, and view the product of your rubbing a piece of amber, 3000 years ago; which, as to power; compared with your electron, is like the elephant, when compared with the ant. Trifling, indeed, as that discovery must have appeared; it was all important to the world. It was the first spark of a science, which, though impeded in its progress, like many other ancient discoveries, was for a period of ages consigned to oblivion. It remained in that state, with occasional twinklings, until the revival of learning; but when the benign influence of that revival began to shed its lustre over the world; electricity, like other branches of science, engaged the attention of philosophers and literary men.

The sixteenth century commenced with some further important discoveries in the electrical science, that afforded to the world some glimmerings of the almost extinguished spark. Dr. William Gilbert, in the year 1600, published the book *de magnete*, which contained some remarks on the singular properties of various other electric substances; he likewise discovered, that the state of the atmosphere had a great influence on such bodies; that dry air was favourable, and humidity rendered the attractive power quite inert.

Till the year 1670, it doth not appear that any farther discoveries were made. This year, Otto Guericke, a Prussian philosopher, made the first electric machine. He made a globe of sulphur, whirled it on an axis, with his hand rubbing against it, and by that means excited electricity, much more powerfully than any had done before him. He also discovered what is called repulsion; that those substances that were attracted by electrics, were also repelled by them. He also, with Mr Boyle, first saw the electric light. These may with great propriety be called bright glimmerings of electric light.

The next discovery of any note, was made by Sir Isaac Newton. He discovered, that when a glass plate was rubbed on one side, the other side also exhibited electric appearances, and shewed electric attraction and repulsion, as strongly as it did on the side that was rubbed; and it is much to be regretted, that this great philosopher did not apply himself to the study of electricity with greater assiduity than he did. These discoveries closed the sixteenth century.

The philosophers of the seventeenth century pursued the science with industrious ardour, and seemed to vie with each other in the investigation of the electric phenomena. Some of them have immortalized their names, by their bold experiments. The illustrious Franklin, when exploring the arcana of the clouds,

"brought down the lightning within his grasp; and wrapt himself in its diffusive rays, and proved to the world, the perfect safety to be found, in its expansive and diluted form." By that daring achievement, he taught us how to disarm the clouds of their lightning, and the thunder of its terrors. In fact, in the year 1752, the spark of electricity discovered by Thales, and fanned to glimmerings of light by Gilbert, Guericke, Boyle, Newton, and other philosophers, now blazed forth on the world, like the meridian sun.

I shall pass over all other discoveries, to the year 1745. The latter part of this year, produced the LEYDEN VIAL OR JAR. Mr. Van Klesit, Dean of Camin, was the first that discovered and felt the effects of the Leyden Vial or Jar; and the first of the following year, Mr. Cunæus exhibited it, in the city of Leyden, in Germany, whence it takes its name. A more particular account, and the manner of preparing a Leyden Vial or Jar, will be found under that head.

The discovery of the condensation of electricity on glass, as exhibited in the Leyden Jar, soon attracted the attention of all the philosophers, both of Europe and America; many of whom had already expressed an opinion, that the electricity excited by the Electric Machine, and lightning, were the *same. The* extraordinary effect and sensation *produced by* the discharge of the Leyden Jar,

soon convinced them, that their opinions were well founded.

Dr. Franklin had before discovered the effect of pointed bodies in drawing off the electric matter more powerfully than others; this idea was suggested to him by Mr. T. Hopkinson. The Doctor, improving on this hint, supposed that pointed rods of iron, fixed in the air, when the atmosphere was loaded with lightning, might draw from it the matter of the thunder bolt, without noise or danger. He says, "the electric fluid is attracted by points. We do not know whether this property be in lightning; but since they agree in all the particulars in which we have already compared them, it is not improbable they likewise agree in this. Let the experiment be made" This opinion of Dr. Franklin was verified in the year 1752. After maturely considering the means whereby he might establish the fact, he fixed on the plan of a kite; but while waiting for an opportunity to put his plan in operation a Mr Dalibard, of France, made the experiment by a pointed rod of iron fixed to a sentry box. Mr. Dalibard leaving home, entrusted his apparatus to the care of one Coissier, on whose courage and understanding he could depend. To him he gave directions to call the Curate of the Parish to witness the experiment, when there should be any appearance of a thunder storm. *At length* the long expected event arrived.

On Wednesday the 10th of May, Coissier heard a loud clap of thunder. Immediately he hastened to the apparatus, taking with him a Leyden Jar, with a brass knob at its mouth. On presenting the knob to the end of the rod, he received the first electric spark ever drawn experimentally from the clouds.

One month after this, the Doctor had an opportunity of verifying his own hypothesis. Assisted only by his son, he sent up the kite, and drew down the lightning to a key attached to the string by which the kite was confined, and received a number of sparks on his knuckle. He afterwards had an insulated pointed iron rod, to draw the lightning into his house; and performed almost every experiment that had been done before by the Electrical Machine.

For the investigation and experiments of philosophers, a new field was now opened; but it was soon found, that experiments of this kind were not always to be made with impunity. Several of those who tried the experiment, received violent shocks; one of whom was struck backwards several paces. Mr. Richman, professor at Petersburgh in Russia, when making the same experiment in his own house, was instantly struck dead.

THE ELECTRIC MACHINE,

Being the *engine* whereby we *mechanically* bring into action electricy, that extraordinary phenomenon of nature; I will in the first place direct as to the making of that machine; not only as to its complete form, for philosophical experiments; but also in its simple state, for medical purposes; with a variety of necessary apparatus; the Leyden Jar, &c. &c. The whole of which will receive a most minute description.

The best Electrical Machine for experimental purposes, is represented in the annexed sketch.

It consists of a glass cylinder, A. about 8 or 12 inches in diameter, and from 12 to 20 inches in length, turning between two upright pillars *of glass*, B.; a smooth tin prime conductor, *C.* with a small brass ball at the end.

s in the sketch; on the other end, or on one de, there must be attached a row of points; ne conductor must be about the same length f the cylinder, and about one-third of its iameter, supported on a glass pillar D. fixed a turned base of heavy wood. The cushion ust also be supported on a glass pillar I. he base that supports the machinery, may e of mahogany, cherry, or any other hard ood, an inch thick, and about 9 or 10 inches ide. The pillar where the wheel is fixed, ust be near the end of the base, so that the heel may pass up and down, to tighten the and: therefore, the length of the base must e governed by the length of the cylinder. he base must have a small beed rising around , to prevent balls and other apparatus from olling off. The cylinder must have tin caps or the necks, prepared by a tinner; they ust be a very little larger than the necks, nd fitted to them in the manner following: ake the necks of the cylinder rough with a le; then put on them a little glue, and wind hread round them until you make them large nough to have the caps go on tight. After ne caps are fitted, (but not permanently) lay he cylinder on a clean table, and with a pair f compasses scribe a centre on each of the aps, by turning the cylinder four times round: he compasses must be opened for half the iameter of the cylinder—that operation will *ive you the* centre of the cylinder on the

caps. Now mark your caps, where they belong, by a scratch on them and the cylinder, so that you may know where they belong, when you want to fit them on permanently. Make a hole agreeably to the centre given you by the scribing, of the size of the axletree, in the end of the caps; then have a tin tube made for each cap of the size of the axletree, and fit them into the caps; then replace them on the necks of the cylinder, with the axletree in them; and while the axletree is in its place, solder the tubes into the caps, and fix them on permanently, with glue or with cement. (*a*) If the cap fits on very tight, glue is the best. There must be a small hole in the caps, to let the air have free access. The axletree must be turned, and made of hard, straight grained wood, with a shoulder at each end, so that it may be steady and not move about. One of the tubes that is soldered into the caps of the cylinder, must project about three-eighths of an inch outside of the cap, and a hole made, to put in a stout pin, to prevent the axletree from turning round in the socket, when the machine is in motion. One end of the axletree must be squared, to receive the pulley or crank, to give motion to the machine, as you may prefer. I use the wheel K. with a band, to give motion to the cylinder, and I think it is the most convenient. The method of fixing it is thus: The pulley must have a groove for *the band*, and the wheel also; the handle of

the wheel ought to turn on an axis, so that you may hold it firm in your hand; the wheel must be fitted to a moveable axis, so that you may tighten the band as you please; and it should be set a little askew, so that the band may not rub against itself while turning. If you want the machine to be perfectly insulated, the band must be made of silk, by twisting a number of skeins together. The glass pillars may be fitted to the base, by the ends being made rough, and thread wound around, to fit them to the holes in the base, and permanently fixed with glue very tight. You must remember, that you must not drive glass pillars; not even with your hand: they must be put in tight by turning them round two or three times. The upper ends of the pillars must have wooden caps turned, for the cylinder to turn on: they must be permanently fixed in the same manner as the pillars are fixed to the base. One of the caps must have a hole for the axletree to run in, the other must be cut down to let the axletree slip in; and when finished, the cylinder must be perfectly level.

That the cushion should be well made and prepared, is all important as to the working of the machine. I shall therefore be very particular in describing the manner of making it. As it cannot well be represented with the machine in the sketch, because of the cylinder hiding it, I have therefore given a separate

view of it in the annexed sketch. No. 1 is a piece of wood of the same quality of the base, formed as represented in the sketch, about two and a half inches wide, six or seven inches long, and one inch thick. The glass pillar 2, is fitted to the piece of wood, as directed for the other pillars. 6 is the head of a screw, the nut of which is to be cut in the base; by means of which, you may adjust the pressure of the cushion against the cylinder. 3 is a hard wood cap, fitted to the top end of the glass pillar 2; 4 is a flat spring made of hard wood, 1 1-4 inch wide, and fitted to the cap; it must be long enough to run above the cushion. The spring will permit the cushion to meet the inequalities of the cylinder. 5 is a piece of wood; pine will do, as it may be covered with morocco leather, or varnished, as will be directed hereafter. *(b)* The piece of wood must be one inch shorter than the straight surface of the cylinder; one inch and a half wide, and one inch thick. 9 shews the formation of the wood, it being a representation of its end. Take a number of strips of flannel or blanket, and form them, one strip on another, into a neat cushion, to fit the inside of the piece of wood 5. Flannel or blanket makes

an excellent, even and smooth cushion.
a piece of dressed buck or sheep skir
inches wide, and as long as the wooc
contains the cushion; glue one edge of
the under part of the wood, the flesh sid
To the upper edge of the leather, a sil
must be sewed or glued, as wide as the cu
is long, and long enough to reach acro
cylinder, to within half an inch of the
that are fitted to the prime conductor;
silk is best—some use oiled silk; but I
never see any advantage resulting fro
being oiled. Figure 7 is a large brass
wooden ball, two or three inches diar
with a screw to fasten the spring to the
that contains the cushion. This ball w
swer for a negative conductor. The
must have a slit in the top end, wide er
for the screw to slip by; that the cushion
its appendages, may be removed, witho
screw being entirely taken out. The
length of the support for the cushion, m
so long, that the cushion may meet the
of the cylinder.

The whole of the work must be don
workmanlike manner, with all the c
rounded and smooth. The machine i
ready for varnishing. (c) Having varn
the machine, we will now prepare it for
ing.

Take a small piece of hard tallow, an
the leather of the cushion so as to gre

all over; then spread some amalgam, that is finely pulverised, on the leather, with a wide bladed knife, very even and smooth. After adjusting all parts of the machine, proceed as follows:

Take a chain, and hang it to the brass knob at the back of the cushion; remove the prime conductor from before the cylinder; and turn the silk flap back over the cushion; set the machine in motion, by turning the wheel in the direction of the silk flap, when lying over the cylinder. Put the back of your hand under and in front of the cylinder. If the machine works well, you will perceive sparks and streams of light passing round the cylinder, and towards your hand; which appearances are very beautiful in the dark. If the machine does not work well, nor exhibit any electric appearances, while in that situation; turn the silk flap over the cylinder, and set the prime conductor up to the machine, with the points towards the cylinder. If the weather is dry, and the wind north of west or east, on setting the machine in motion, you will most assuredly have sparks on presenting your knuckle to the prime conductor. But if, contrary to all expectation, there should be no signs of electricity, you may then conclude that your cylinder is one of those, that wants, what I call coaxing; *(d)* which may be done thus: Take out the axletree from the cylinder, and on the first clear day, when the sun shines

bright and warm, let the cylinder be warm by standing in the sunshine. Then turn it the cylinder as much varnish (*e*) as you thi will cover the whole of the inner surface; ke turning it round, for the varnish to sprea and when the varnish has evenly covered t whole of the inside, you must continue to tu it round, until it is completely set. The ho where the axletree came out, must be k open, during the operation, for the air to ha free access. Leave the cylinder to stand wh it can have the dry air, for three or four hou and it will then be fit for use. You must n dry it by the fire, because of the danger breaking it. When the varnish is dry, y may remount it, but not before; then proce as first directed, and you will have as mu electricity as you can manage.

For a machine that is intended for medi purposes only, you may dispense with all t glass pillars, except the one for the pri conductor; although, when it is complet insulated, it is much better for that purpo than one that is not; because, by the aid insulation, you can retain much more elec city.

ELECTROMETERS,

Are instruments intended to measure a determine the different states of electrici *they are of* various kinds. I shall descr

but two: the pith ball, and Lane's electrometer, so called from its inventor.

The pith ball electrometer is intended to determine the different states of the electric fluid, and exhibit its intensity. It is placed on the prime conductor, and consists of a stout brass or iron wire, seven inches long, with a smooth wooden ball on the top, and two very delicate pith balls, suspended by fine linen threads, from the top of the wire, under the ball. The threads must be about 3 inches long. The stem must be made very smooth, with fine sand paper, and then placed on the prime conductor, as represented in the sketch. The pith ball electrometer, although it appears but trifling, is a very useful part of the electrical apparatus. It is by that, we know when the electrical machine works well, and when the Leyden jar is charging; without it, we should be working in the dark.

Lane's electrometer, is also a very useful instrument; it is by that, we measure the electrical discharge of the Leyden jar, and regulate its quantity. It is important in many electrical experiments, and is indispensable in medical electricity. Its form, as exhibited in the sketch O. is so easy to be understood, that it needs but little description. The two upright parts, may be of wood or metal; the upper horizontal piece must be of glass; the lower, a piece of wire, with a wooden ball on its outer end; the inner ball must be of metal,

and very smooth: the wire must slip easily through the lower ball.

INSULATED STOOL,

Is a necessary part of an electrical apparatus. It consists of a piece of board, with four glass legs. A very cheap one may be made, by having a square piece of board, the corners of which must be rounded, and made smooth in every direction, with a hole in each corner, large enough to receive the neck of a common black bottle; the edges of the holes must also be rounded. A chair or bedstead may be insulated by cakes of beeswax, or stout tumblers, put under the legs. Glass, before it is used for an insulator, must always be wiped, and dryed by a fire.

DISCHARGER,

Is an instrument used for discharging a Leyden jar or battery; and is represented as P. in the sketch of the electrical machine. It consists of a stout brass or iron wire, bent in the form of a semicircle, with a small metal ball on each end; the middle of which is fitted to a glass handle: long glass vials, or proof glasses, make good insulating handles.

Chains, and other small apparatus, will be found necessary: brass wire is best, and when *it can be* obtained, it ought to be used for

chains, and other apparatus, as it does not rust. Chains with long links, and a short one between is better than when the links are all short.

THE LEYDEN VIAL, OR JAR,

Forming a very important part of the electrical apparatus, requires a particular description; not only as to its preparation, but also as to the cause of its receiving a charge of electricity. It is represented by N. in the sketch.

Take a thin glass bottle or jar, of any size you please; coat both sides with tin foil, or tea chest lead. Let the foil or lead be put on with glue or beeswax, and extend to within two and a half inches of its mouth. Fit a cork stopple to the mouth, the outside of which must be very smooth; insert a piece of small wire, doubled, through the cork stopple; let the bend of the wire project a little above the top side of the cork; the ends of the wire must enter the jar, and touch the inside coating. For a single jar, it is best to have a brass knob projecting from the top of the stopple; for that purpose, take a piece of stout brass or any other metal wire, about three inches long; fit a smooth metal ball to one end; the other end must be inserted into the cork, so as to touch the small wire.

For a small jar or bottle, you may dispense with the brass knob; but in that case the bend

of the wire connected with the inside must extend a little further out of the bottle. A jar with a large mouth is more convenient to coat on the inside, but a small mouthed jar may be coated with brass filings. After you have put some glue on the inside with a brush, then put in the filings, and shake them round the bottle. You must wipe off the filings that may be within two inches of the mouth, with your fingers. The uncoated part of the jar ought to be covered with sealing wax varnish; for dampness will not collect on glass that is varnished, so soon as when it is naked.

When you want to increase the quantity of electricity, you may add a number of jars; and they ought to be nearly all of one size: one of the number is sufficient to have a brass knob, to make your discharge from. When a number of jars are combined, they must be connected by a wire passing through the bend of all the small wires; and their outside coatings must all be connected together, by their standing on tea chest lead or tin foil, before you begin to charge. In this form they are called an electrical battery. In making your discharges from the battery, it is best to connect one ball of the discharger to the bottom coating; and bring up the other ball to the knob of the battery.

A pane of common window glass makes a good Leyden jar, by coating it on both sides, *as directed for* a bottle, to within two inches

of the edges; and by setting it in a grooved piece of wood, you may support it in an erect posture. To make it convenient to be used, it must have a small half round piece of wood, with a hole to hook a chain to, glued or cemented to the coating of each side, and when charging it, a chain hooked to the piece of wood, must connect the coating of one side with the table; and the other side, by another chain, must be connected to the conductor of the machine. To discharge it, bring the chain connected to the table, up to the conductor, and a discharge will take place, the same as from a bottle.

If your jar should be perforated by a spontaneous discharge, you can repair it, if the cracks do not extend over an inch, by taking off the coating a little further than the cracks, and then covering the hole with hot beeswax, with a little rosin melted with it. It must be put on very hot, that it may firmly adhere to the glass, and about a quarter of an inch thick; then cover it again with the coating.

TO CHARGE THE LEYDEN JAR.

That a clear and satisfactory solution of the appearance of the two states of electricity, as exhibited in the Leyden jar, will ever be given, is very doubtful. The author would offer it as his opinion, that the charging of the Leyden jar, when in connection with the *electrical* machine, is effected by the influ-

ence of the electric fluid; which, while condensing on one side of the jar, is acting with increasing effect, from the centre of the electrified substance, and produces a contrary or rarefied state on the other side; and would say, that the Leyden jar is in a highly excited state; by the electric fluid being condensed on one side, and rarefied on the other: for such is its appearance when charged.

After seeing that your machine is in good order, and cleaned from dust; the cylinder, and all the insulators, wiped with a clean and dry handkerchief; and all unnecessary apparatus removed from about the machine, proceed with the following experiment, which, if performed with care, will greatly elucidate the phenomena of the Leyden jar:

Provide a large pane of window glass, the thicker the better, and four glass tumblers of equal height; warm and wipe them dry; set the tumblers on a clean table, and the pane of glass on the tumblers, one at each corner; set the Leyden jar on the middle of the pane of glass, and your jar is completely insulated. Connect the knob of the jar by a chain or piece of wire, with the conductor of the machine; the pith ball electrometer must be in its place on the conductor. Set the machine in motion, keeping your eyes on the pith balls; you will see that they instantaneously *rise*; which is an indication, that *your jar is* not receiving any electricity; you

may keep the machine in motion some time, and then examine the jar, by taking the discharger, and putting one of its balls to the outer coating of the jar, and bringing the other ball to its knob, and you will find that your jar has not received a charge. The reason is, because the jar is insulated; and this experiment is performed for the purpose of shewing the young electrician, that it is necessary, in order to charge a Leyden jar with the electric fluid, that one side of it should communicate with the ground, or the jar cannot be charged. Proceed with the same experiment, and put your finger on the outside coating of the jar, and keep it there while the machine is in motion; observe the pith balls, they now rise slowly, which indicates, that the jar is receiving electricity; and when the pith balls are above a horizontal line, the jar is charged, and if you continue the machine in motion for any time, the electricity will either discharge itself, over the uncoated surface, or perforate a hole for its passage through the glass. The outside of the jar can also receive a charge, by removing the chain or wire from its knob to the outside coating; in this experiment, the finger must be put on the knob of the jar, to communicate it with the ground; observe the pith balls, and proceed as before; excepting you must, to discharge the jar, put the ball of the discharger first to the knob, instead of the coating, and bring the other ball to the

coating, and the spark will appear to come from the coating to the ball of the discharger. Proceed again with either of the foregoing experiments, the first is the best, and place small, light pieces of paper, cut in various figures, under the pane of glass; set the machine in motion, and the papers will rise and jump about as though they were animated, and by their motion, they make a communication with the ground, and the jar will charge, but slowly. Now take the jar from the pane of glass, and set it on the table, with the knob connected with the conductor, as before; the machine being in motion, the jar will charge as well as though your finger was at the coating. The table now acts as a conductor, to communicate the outside of the jar with the ground, instead of your body, as was the case in the other experiments.

General observations on Electricity, together with the Author's opinion of the cause of its appearance in the Atmosphere.

There has no satisfactory hypothesis, concerning the cause of electrical phenomena, as yet been advanced; although the subject has engaged the attention of the most eminent philosophers both of Europe and America. They were referred, by Franklin and some other philosophers, to the presence of a peculiar *fluid*, existing in all nature, exhibiting

itself by appearances that have already been described, whenever its equilibrium is disturbed. Others have plausibly argued for the presence of two distinct fluids. Others, again, have considered the effects as referable to peculiar exertions of the attractive powers of matter; and have regarded the existence of any distinct fluid or form of matter, to be as unnecessary to the explanation of the phenomena, as it is in the question concerning the cause of gravitation. Its phenomenon has also been referred to the oxygen of the atmosphere.

In these discussions of the electrical phenomena, it is not the intention of the author to enter into arguments to prove what are the component parts of electricity, or what its essence or materiality may be; nor as to the correctness of any of the hypotheses that have been advanced for its solution. He will only observe, that from the experiments he daily makes, and from the attention to, and examination of, the destructive effects of lightning, on buildings, ships, and animals, he is led to believe, that electricity is a material substance; but possessing few of the grosser properties of matter; a subtile and elastic fluid, continually in motion, changing its states on different parts of the globe; and in all the operations of nature, it is a grand and important agent. If all the materials of the globe had possessed a power of conducting, and

permitting electricity to be equally distributed over nature, it must have remained in an undisturbed, and unexcited state; its influence could not have been any where known or felt. As far as our knowledge of the works of Deity extends, they all appear to conduce to the general benefit of animated existence. He has manifested his wisdom, by so constructing and arranging the matter of the globe, that this important agent should be active, and its disturbance continual: the health of all nature requires that it should be so. Witness our feelings in hot, sultry, and damp weather; we then languish and faint. The humidity of the atmosphere, permits the electrical influence to equalize itself on that part of nature; but we are not to suppose, that such is its state on every part; perhaps, not over fifty miles, the inhabitants are enjoying a beautiful north wind, occasioned by the activity of the electric principle; the influence of which will soon arrive to our part, and we also shall feel the benign effects of its active state.

May not those long calms that are experienced by mariners on the ocean, between the tropicks, be caused by the undisturbed state of electricity? They often continue for several weeks, and even months, without breeze sufficient to move a vessel over fifty miles during their continuance. They are generally broken up by fresh breezes from the north, and lightning, indicating an excitement of the *electric principle*.

Although we have occasionally to witness the dreadful effects of the unrestrained power of electricity; yet without the influence of this important agent, all nature would languish and die. This active and powerful principle, is governed by certain fixed and undeviating laws: thus far shalt thou go, but no farther, is the irrevocable mandate of omnipotence.

It is well known to philosophers, and to all those who are acquainted with electrical machines, that there are certain bodies that conduct electricity freely, silently, and without being seen, while on their surface. And there are other bodies, that offer a very great resistance to its passage. The atmosphere is the body that opposes its passages with the greatest force; and metal is the body that is its best conductor. The effect of electricity is discovered to our senses, only when passing over or through such bodies as are called electrics, imperfect, or non-conductors.

The author, before he proceeds farther in his observations on the excitation of electricity, will state what is considered as the general result of its condensation, on different parts of nature.

During thunder storms, the discharges of electricity are sometimes from cloud to cloud; sometimes from the earth to the clouds; sometimes from the clouds to the earth; as electricity is condensed or rarefied on either. When aqueous vapour is condensed in the at-

mosphere, the clouds formed are usually more or less electrical; and the earth below them is brought into an opposite state, by what some philosophers call induction; but what he should call the influence of the condensed state acting on the other. It is the same principle that takes place, when charging the Leyden jar. While condensing the electric fluid on one side of the jar, by the influence of that condensation, the other side is brought into a contrary or rarefied state. When the electric fluid is condensed, either in the clouds, or on one side of the Leyden jar, so strongly that they can receive no more, they will then spontaneously discharge their superabundant fluid. That in the jar, will either pass over the uncoated surface, or perforate a hole for its passage through the glass. The clouds will discharge their condensed electricity through the non-conducting body of the air, with light and sound, indicating its intensity and quantum. That from the clouds will be more or less intense, and of longer or shorter duration, according to the quantity of air acted upon, and the distance of the place where the report is heard, from the point of the discharge.

It may not be uninteresting to give a farther illustration of this idea. Electrical effects take place in no sensible time; it has been found, that a discharge through a circuit of four miles is instantaneous; but sound *moves at the* rate of about twelve miles

in a minute. Now, supposing the lightning to pass through a space of some miles, the explosion will be first heard from the point of the air agitated nearest the spectator; it will gradually come from the more distant parts of the course of the electricity; and last of all, will be heard from the remote extremity; and the different degrees of the agitation of the air, and likewise the difference of the distance, will account for the different intensities of the sound, and its apparent reverberations and changes. The excitation of the electric fluid, mechanically, is performed with the electrical machine, by the friction of the silk rubber against the glass cylinder, assisted by the amalgamated cushion. The friction of the same materials, is the cause of the electrical excitement, condensation, or rarefaction, in the atmosphere or earth. This can be proven by many facts, that are continually taking place, in almost every department of nature. The following instances may be adduced in illustration, and many persons have experienced them: if a person wears two pair of silk stockings, in dry, cold weather, when pulling the outer one off, electrical sparks appear. When separating two garments of flannel from our bodies, and that in dry weather, the same phenomena appear. If we rub with our hand, the back of a black cat, the same way the hair inclines, electricity is again disturbed. By combing long dry hair, in frosty

weather, with an iron comb, the person whose hair is combed standing on a cake of beeswax, or any other non-conductor; electricity is also discovered. We find in all these experiments, that electricity is excited by the friction of electrics against electrics, in connection with non-electrics; and exhibited to our senses by forcing from its condensed state, through the electric, or non-conducting bodyof the air.

We will now see how far these premises may be applied to the cause of the appearance of atmospheric electricity. When by heat, or other causes, aqueous vapours arise, and condense in the atmosphere, the clouds formed are always more or less electrical; they are conducting bodies, like the prime conductor of an electrical machine, surrounded by the electric body of the air; and they move with more or less velocity through that medium. So does the cylinder of an electrical machine. Where there is a motion of one body by another, there must be friction. When that motion is by an electric, against a non-electric body, if they are surrounded by the air, there must be electric appearances. Such is the case with the clouds, or the conductor of an electrical machine. As there are many clouds floating in the atmosphere, the larger will attract the smaller, and be condensed into one large thunder cloud. Soon after this cloud *is formed*, a cloud in the opposite part of the

a contrary state, from the one first formed. When the two clouds approach sufficiently near for the condensed electricity of the one, to be discharged to its rarefied state on the other, lightning begins to appear, by electricity forcing itself a passage through the electric body of the air, to its rarefied state in the other cloud. Such appears to the author to be the cause of the electrical excitement in the atmosphere; and that its appearance is occasioned by its passage through electrics, imperfect, or non-conducting bodies.

General observations on the usefulness of Metalic Conductors; and instances adduced to shew that improvements may be made in their present formation, whereby their influence may be farther and more widely extended.

It is a fact, that there are solitary instances of buildings being struck by lightning, that had what were supposed good metalic conductors. These instances would lead some to suspect their utility; such as take but a cursory view of them. The author has examined eight such buildings; and in every instance but one, there was evident protection derived from the conductor. That one, was of such an extraordinary nature, that it requires a minute description.

The building was as well guarded as any *one would have* supposed necessary; ever

many of those who are conversant with the electrical principle, would have concluded that the house was as completely protected by metal as it was possible for it to be. A very particular description of the building and its situation, will therefore be given. It was the dwelling house of Dr. Read, in the city of Savannah. Some time in the year 1822, it was struck by lightning, and examined by the author about one year afterwards. The building was a square, with four rooms on the floor, and a hall through the middle, three stories high, with a kitchen at the southwest corner, on the ground floor. The house fronted north, and had two chimneys, one in the centre of each half; each chimney had a round iron conductor, with one point to each in the air, and blunt in the ground. Both of the conductors had had a silver point on the top; but when they were examined, one of the silver points was off. The roof of the building was covered with zinc, and had metal gutters around the eaves, with water conductors also of metal, leading to the foundation. The western conductor descended from the chimney along the southwest corner of the building, into the ground on the south. The door that entered the passage leading to the kitchen, was on the south side of the building, under the back piazza. It was stated that the *cloud* rose in the south; and that there was *another* building struck with the same flash of

lightning. The Dr. in a conversation with the author, stated, that he supposed the lightning was drawn to the building by the western conductor, which carried it to a bell wire, that was on the inside of the wall, opposite and near the conductor; and from the bell wire to a small negro child, which it killed, that was in the arms of its mother, sitting against the partition wall, through which he supposed it went, and likewise through the door alluded to above. In this supposition the Dr. must have been mistaken; for there was no marks of any violence from the lightning through the building to the bell wire. The bell wire being very small, it would have been melted and totally destroyed, by such a discharge of electricity; which was not the case. There being no signs of the lightning having passed from the conductor to the bell wire; and the first evidence of the effect of electricity appearing to be at the door above mentioned, the conclusion must be, that as the cloud rose in the south, the lightning came obliquely from that quarter, and discharged itself through the door; went through the partition wall, and killed the child. The conductors that were fitted to the building, the points in particular, were at least 40 feet from the direct passage of the lightning to the door; therefore they could not have had any attractive influence over the lightning. The nearest metal to the door, was the middle of the southwestern con-

ductor; that being round and smooth, presented no rough or sharp corners for attraction, therefore could afford no protection to the door. If lightning always discharged itself in a perpendicular direction, a house guarded by metal conductors as the above building, would be always safe from such discharges, and with more certainty, if their conductors were pointed in the ground. It is well known that the electrical discharges are often times horizontal; which must assuredly be the case when the electricity is passing from its condensed state in one cloud, to its rarefied state in another; we therefore can have no reason to expect protection from such electrical discharges, by conductors formed as the Doctor's were. It is not the metal alone, that is to protect the buiding, it is its formation. It being a good conductor, we must give it a power to attract the lightning to itself from the building. Directions for giving that power to conductors, may be found under the head of 'Directions for constructing Conductors, &c.

The latter part of the same year, after a violent thunder storm, it was discovered, that the lightning had descended the conductor, on the south side of that large and elegant meeting house, in Market-street, Savannah. It appeared to have left the conductor at the foundation, and forced a passage through the *stone work*, to a large bar of iron, that was

deposited around the foundation, to prevent a partial settling of the building. It continued on that bar the width of the house, and then forced a passage through the stone work at the north side of the building, leaving small marks of having crossed the street. The conductor is a round smooth bar of iron, with the top pointed above the vane, and is blunt in the ground. This discharge of electricity was evidently horizontal, from cloud to cloud. In its passage through the air, it met with this very elevated conductor, by which it was drawn from its course, and in a degree expanded and weakened by its passage over the rough bar of iron in the foundation.

Two instances have come within the knowledge of the author, and he has received satisfactory information of six others, in which the earth around the conductors was thrown up, and a large hole made. Boxes, also, that have occasionally been fitted around conductors, above the ground, have been split and torn to pieces by discharges of electricity through their conductors.

These rare instances of electrical discharges, cannot be satisfactorily accounted for, upon any other principle, than, that such discharges were from their condensed state in the earth, to their rarefied state in the clouds. Their meeting with blunt pieces of metal in their conductors, for those conductors were blunt in the ground; they were received on

them as sparks, such as we receive on our knuckle, from the conductor of the electrical machine, only thousands of times stronger. If the conductors had been pointed in the ground, instead of being left blunt, these accidents could not have happened; for the points would have presented an easy passage for the fluid to the clouds. Here we have clear evidence of the necessity of conductors being pointed in the ground. And in the instance of Dr. Reid's house, where, if the south-western conductor had presented rough and sharp corners, it is more than probable it would have drawn the lightning to itself and protected the child. In the instance of the lightning descending the conductor of the meeting-house, it was attracted, by the rough bar that was in the foundation, from the round conductor, and there expanded and weakened; so that there was very little effect discovered from it, after it left the bar.

In all these cases there is unquestionable proof, that the present construction of conductors, requires some improvement; whereby their attractive influence may be farther and more widely extended. And the lower end of the conductor ought to be so formed, as not only to receive the electric fluid with ease, but to part with it with ease also. Place a point at the end of a conductor of an electrical machine, opposite the points facing the *cylinder*; set the machine in motion, and you

will find, that the electricity of the cylinder is carried off, by the point, as fast as collected.

It is known to those conversant with electrical machines, that the first directions given for their management, are, that you must remove all rough pieces of metal; wipe off the dust, &c. and that the workmanship of the machine, should be smooth and without sharp corners. These directions are given for very obvious reasons: those rough pieces, dust, and sharp corners, draw off the electric fluid as fast as it is excited; thereby weakening its power.

When we perform experiments with an electrical battery, requiring strong charges of electricity, we are often disappointed in our expectations of the result, from causes unknown; when, on a strict examination, we find, that we have lost at least half of the charge, by the roughness of the connecting chains and wires. These remarks are made by the author, that the reader may see the force of the observations respecting rough cornered and pointed metallic conductors. If it is necessary that we should remove those rough and pointed bodies, from about our electrical machines, that its power may not be weakened or destroyed; surely it is reasonable to suppose, that if we placed such bodies in the track of electrical discharges from the clouds, we should thereby expand and weaken their destructive force.

Directions for constructing Metallic Conductors, such as the author's experiment warrant him in recommending to be more efficient, and their attractive influence to extend farther and wider, than those of the present formation.

First, all the metals are better conductors of electricity, than any other substance whatever; but from their cheapness and convenience for erection, copper and iron are to be preferred to any of the others. Copper is the best conductor; but it is dearer than iron. I should therefore prefer bars of iron, about half or three quarters of an inch square, according to their elevation; the higher they extend, the larger they ought to be. All their corners ought to be made rough, with a cold chisel; two opposite corners pointing up, and two down; with three points in the air, and one in the ground; they must be made continuous throughout, by welding, riveting, or by being screwed together. They must extend from three to five feet above the highest part of the building; and descend into the ground the same distance. All points must be filed sharp with a coarse file; those in the ground, must be painted with two or three coats of black paint, to prevent them from rust; and the points in the air also, unless you should prefer the following method of pointing them. *The author* thinks, if his recollection is cor-

rect, that they were first recommended by a Mr. Patterson of Philadelphia. After forming the top ends for the points, instead of drawing them out to a point, file them off, and leave them square; then drill a hole in each of the tops, about half an inch deep, large enough to receive a solid black lead pencil; each pencil must be pointed sharp, and inserted into the hole tight, with black paint; but not before they are ready for erection, as they would be in danger of being broken. Half inch nail rods make very good conductors, as they want nothing done to them but pointing and welding together. By reason of their lightness, they must be cheaper for small buildings than other iron. Their sharp corners, when erected, ought to be on the outside, that their attractive influence may be more widely extended. The author does not attach much importance to the black lead pencil, although it is not fusible, like iron. Some have recommended the points to be covered with silver, gold or platinum, on account of their not being so fusible as iron; but it is his opinion, that very sharp and rough points of iron or copper, will not often be melted.

In thinly settled towns, or in the country, if the building is more than 25 or 30 feet long, it ought to have two conductors; one at each end, connected together by nail rods, lying with their sharp corners up, on the ridge pole of the building; and if there are chim-

neys at the ends, let the rod go round or over them, and bend round the upright rods. If there be a chimney in the middle of the house, a conductor ought to ascend by the side of that, and be connected to the ridge pole, as

in the annexed sketch. To secure the conductors to the sides of the building, or roof, you may take iron staples, with a hole for the rod to pass through, and drive them into the brick or stone wall; or you may secure them by wooden cleats, with a hole for the conductor to pass through, which may be nailed to the building. Bone, horn, or the neck of a glass bottle, is of no use, to be put into the staples, as they possess no power to hinder the lightning from passing from the conductor to the house.

Churches ought to have two conductors, and they must be larger than for buildings of common height, and strongly secured to the sides of the building, one at the steeple, and one at the other end; and both connected by nail rods on their roofs, as directed before. The conductor at the steeple, affords no security to the other end, from a cloud arising in that direction; but its great elevation *extends its influence* at least 300 feet around,

against any descending lightning; and farther to the leeward of the rising cloud.

All projecting pieces of metal, iron balconies, pallisadoes, gilt balls, pieces of iron let into brick walls, metal gutters around the eaves of buildings, iron supports for vanes and weathercocks, ought all to be connected with the main conducters, or with the ground. All balls or blunt bodies, whether of metal or wood, around steeples of churches or other buildings, are dangerous, and ought to have a nail rod, pointed and connected to the main conductors.

Barns, cotton gin houses, rice and other mills, and all buildings where vegetable substances are deposited, are in great danger, from the steam or vapour arising, caused by the heat of such collections. Scarcely a season passes, without a number of such buildings being set on fire and destroyed by lightning. Buildings of this description, ought to have at least two conductors, erected as proposed for long buildings. Common half inch nail rods, or smaller, will do; their expense would be trifling, they need only to be pointed and welded together, they are then fit to be erected. Kitchen chimneys, where smoke is continually ascending, ought to have a conductor; a small nail rod would answer, the cost of which could not exceed three dollars. School houses, where so many children are *collected*, ought never to be without a con-

ductor; the present season has given sufficient warning to those who have the care of such buildings, to make it an object of their attention.

If a large, thick settled town or city, had a good pointed metallic conductor to every elevated spire, and to every fifth building, that city would then present such a number of metallic points, to draw off the matter of the lightning from the clouds, that there would scarcely be heard any thunder, while clouds were passing over that city. The equilibrium of the disturbed electrity would be restored silently and without danger.

The author will now direct the attention of the public authorities to the defence and protection of magazines, and other depositories of gun powder, arms, munitions of war &c. Explosions of powder are always attended with the most disastrous effects. With the destruction of a great many lives, its influence must be most sensibly felt in forts and garrisons; the consequence of which must be the total loss of powder, and their surrender to an inferior force. Taking into consideration the danger of such explosions, the expense of their protection ought to be only a secondary object; the best and most certain means ought to be used for their defence. In several publications, the author has seen it recommended, *to surround* the insides of such buildings by *non-conducting* materials. If their authors

meant them as the only defence, they are no defence, more than the buildings are already possessed of; for if the air within them is dry, the powder is already surrounded by the best non-conductor. Having maturely considered on the subject, and made many experiments, with a view of ascertaining the most certain defence that can be obtained; the following plan is recommended, with full confidence in its powers, as affording the best protection from the effects of lightning, for such buildings.

See the annexed sketch, the conductors of which consist of three bars of iron or copper, from one half to three quarters of an inch square, extending eight feet above the centre of the building, and descending into the ground five feet, and pointing outwards. The bars are continuous throughout, by being welded or screwed; their ends in the ground are drawn out to a long square point, made rough and sharp with a coarse file. In the ground they are painted with two or three coats of black paint, to protect them from rusting; tar or pitch will not do, for those substances are non-conductors; and to cover the points with electrics, would weaken their attractive power. Black paint is composed of oil and charcoal, or what is the same, lamp black; and

although oil of itself is a non-conductor, yet if lamp black be mixed with it, the whole substance becomes a conductor. The conducting power of black paint will be noticed hereafter. The tops of the conductors are fitted with black lead pencils as before directed, and brought together and welded or an iron strap may be worked around them, one foot below their tops. If they are put up without pencils, the points must be made very sharp with a coarse file, and painted as directed for the points in the ground. The points must be spread, as represented in the sketch. The corners of the bars ought to be made rough, by nicking them with a cold chisel. For a square building, with the roof ascending to the centre, it ought to have four such bars; only they may be smaller; nail rods would answer very well, with their sharp corners outwards; they may be secured at the top as before directed, descending on the corners of the roof and building to the ground. For an oblong square building, with a round roof, and gable ends, a conductor must run up each corner, and they must meet at the top of the gable end, and end with three points in the air; both conductors must be connected along the centre of the roof by nail rods. Nail rods, from their being rough, may be used almost in every instance; they do not require to be so large as smooth bars. Magazines protected as above directed, may be con-

sidered well protected from ascending or descending, and in many instances, from horizontal discharges of electricity. But the discharges of electricity are more frequently from cloud to cloud, than otherwise, and it often takes the earth in its passage, doing considerable damage, even to buildings with conductors. The author would recommend, for protection against such discharges, nail rods made continuous by welding, carried around the building, near the foundation, and connected to the main conductors and the ground, by several of the same rods. As such buildings are sometimes covered on the roof with metal, the roof, in such cases, ought to be connected to the conductors or ground. He would suggest the propriety of constructing magazines of, or covering them wholly with, sheet iron, or sheet zinc, or what is better, copper; with a few points around their tops or roof. They would be completely safe from lightning, and perhaps their cost would not be greater than a brick building, and the safety of the powder would be much increased.

Directions for putting Metallic Conductors to Ships, &c.

In putting conductors to the masts of ships, &c. there are several things to be taken into consideration. First, they cannot be continuous *throughout* their whole length, on account

of the necessity of lowering the upper mast at sea in storms; neither can they be rough, on account of the rigging rubbing against them: therefore, copper or iron chains, are the most convenient for conductors for vessels. They may be made separate, in such lengths as may be required; the links ought to be as long as convenient, and about three eighths of an inch diameter. Chains offer considerable resistance to the passage of electricity, and tend greatly to weaken and expand its force. The author himself having followed the seas for some time, proposes the following as the best and most convenient method for fitting the chains to the mast. He would take a piece of iron or copper, three-eighths of an inch square, and about eighteen inches long, sharpen one end to a point, the other end turned round to form an eye to hook the chain to. He would then fit such a one to the head of each upper mast; that is, to each mast above the main mast, letting them by a groove into the head of the mast, so as to be smooth and even with the outside; if they shew their points one and a half inch above the mast, it is sufficient. You will then have a point, that is snug and out of the way of the rigging; and when you lower one mast, you have a point at the other, to hook the chain to. In fitting the points, you will let them into the after *part of* the mast, with their eyes projecting a *little*. The chain of the upper mast may be

secured to the next eye, and the next chain to the next eye, and so continued on, to the main shrouds, and fastened by stops along the shrouds to the water. If the ship has chain backstays, the upper chain may descend and be secured to their upper part, and they also must be connected with the water. All conductors that are connected with the water, ought to be pointed. A ship or any other vessel, to be well secured against lightning, ought to have such conductors fitted to the top of each mast, bowsprit and gaffs.

The following method has also been recommended: Take rods of copper, about half an inch square; let them into the masts, from the uppermost down to the deck, by a groove for them to fit in tight, in the after part of one mast, and the forward part of the next, so that the top of one meet the foot of the other; crossing the deck, and over the gunwails into the water. The author would recommend that the upper and lower ends of all the rods, should be pointed; the points at their lower ends would tend greatly to weaken the electrical discharges. He cannot feel satisfied that this method is perfectly safe; he fears that a strong charge might, when passing down the conductors, be the means of splitting the mast. If the conductor was terminated on the top by a ball, instead of a point, he would have no doubt as to the result; for he has made several experiments with power-

ful electrical batteries, to test their safety, and has found in several instances, when passing a strong charge of electricity, by a piece of wire fitted into a round piece of wood, as proposed for the mast, that the wood was split in two or three parts. In these instances, the charge was received on a ball; but when the charge was received on a point, no injury was sustained. The method is a very snug one, and if the points are very sharp, they may be safe. If a ship, &c. had a chain cable, it would add to its safety, to have it extended along the deck, with the end connected with the water; and during thunder storms, while at anchor, or at the wharf, the end of the chain cable that is on board, might be hoisted up the mainmast as far as it would reach, and it would add much to the ship's safety.

Directions to travellers who may be overtaken by thunder storms, and to persons who may be in houses without conductors; whereby they may in a measure avoid the effects of Lightning.

Travellers, when overtaken by a thunder storm, ought never to take refuge under trees; for altho' a tree may afford a temporary shelter from the rain, yet still they expose themselves to the effects of lightning. Trees, being elevated objects, that present many points for attraction, and at the same time not very

good conductors; if the tree should be on the track of the lightning from its condensed to its rarefied state, and animals, which are better conductors, should be near the body of the tree, the lightning would leave the tree, and pursue its course thro' them, thereby endangering their lives. Instead of seeking protection under such dangerous objects, they had better keep on their way home, a short distance from every elevated object. If the traveller is on horseback, he had better alight, a little distance from a high tree, until the heaviest of the thunder has past. A soldier that is travelling with his musket, or standing sentry, should, in a thunder storm, have his bayonet fixed; and if his ramrod is metal, draw, and with his handkerchief connect it to the breech of the barrel, leading it from thence to the ground; and set it a little distance from him, or against his box; in that situation, his musket will afford him great protection.—There have been several persons killed, together with their horses, by lightning, when riding home from musters, with their muskets on their shoulders; it would be prudent for such persons, when overtaken by a violent thunder storm, to dismount a little distance from a high tree; but not directly under it, and fix their muskets as before directed; set themselves down on a log, or any other body that is convenient, with the musket standing between them and their horses; in that situation it would afford protection to both.

As iron is more or less rough, with sharp corners and ends, those inequalities give it a power of attracting electricity; therefore, the author would consider himself safe from the effects of lightning, in blacksmiths' shops, or stores where bars of iron are deposited; especially if some of the longest bars were standing around the sides of the building. When standing near iron gates, pallisadoes, or any metal that extends above the head, and reaches the ground; we may consider ourselves in a place of safety. We ought never to stand under projecting pieces of metal, that are often around buildings, unless they be connected with the ground, by a metallic substance. It is unsafe to hang guns or muskets along the beams of houses; it is safer to stand them in the corner of the building, where they can assist the passage of the lightning.

Steam boats, having great quantities of rough, projecting and sharp cornered iron on board, the most of which is connected with the water, may also be considered places of safety against lightning. The author was informed by some one on board a steam boat at Charleston, that the boat was struck by lightning, while going into the harbour, and the boiler was burst by the flash; but according to the known laws that govern the electric fluid, it is impossible that a steam boat could be materially injured by lightning. As the *boilers* of steam boats are frequently bursting,

they are as likely to burst during a thunder storm, as at any other time; a flash of lightning passing near a steam boat, while the boiler is under a high pressure, the concussion of the air caused by the flash, might occasion such an accident.

All metal about a building, that is connected with the ground, adds to its safety; and all that does not, increases the danger. If a house has but one conductor, the safest place in that building, is in the room adjacent to the conductor; if you are in a house, during a thunder storm, that has no conductor, it is prudent to shut all the doors and windows, to keep the damp air out; and sit, or lie down, in the middle of the room; a recumbent posture is safer than an erect one A person is not so safe when lying on a bed, that has high posts, as when lying on the floor, with blankets, or any other pallet under them; for bed posts have generally nails or pieces of wire on their tops. A person swinging in a hammock that is suspended by a silk or hair cord, is as safe as he can be, in a house that is without a conductor.

While reading these pages, it would be best for the reader to frequently look back to the list of conducting, imperfect, and non-conducting bodies, to refresh his memory respecting their powers. For metal to have a power to attract lightning, it must have rough corners *and points*; round and smooth metal

does not attract the electric fluid more th
any other round and smooth substance. Ch
coal is a better conductor than our bodi
when alive; but it cannot be employed a
conductor for our safety: therefore we are
consider that we are the next best conduc
of electricity to metal; and that no other su
stance but metal, can protect us from the d
tructive force of lightning. The reason th
the author would give, for recommendi
persons to retire to the middle of a room
safety, during violent thunder storms, a
shutting their doors and windows, would
because, when in that place, they would
surrounded by the imperfect conductors
the building; down which it would pass, l
fore it would pass through the dry air of t
room to them. Here he would remark
the conducting power of our bodies wh
alive. Having had frequent opportunities
administering electricity to persons wh
animation was suspended by submersion, a
otherwise; he has always found, that wh
he could pass electrical shocks thro' the bo
he succeeded in resuscitating them; but wh
the shocks passed over, and were seen on
body, without moving it, he could not succ
in restoring animation. He has frequen
performed experiments on small animals,
passing strong charges of electricity throu
them; and when repeating the experime
if they were killed by the first, the secc

would not go thro' them; but would be seen passing over their bodies. If it is the blood, as supposed by some philosophers, that conducts electricity thro' living bodies, why does it lose that power almost instantly after they are dead; even before the blood is coagulated? If it is not the blood, what can it be, that conducts the electric fluid through living animals, that they lose immediately after they are dead?

It is electricity in an active state, that is the supporter of vitality, and its own conductor thro' the animal body; and when the animal is dead, the Electric fluid in that body is in a latent state, as it is in all other inanimate matter. It is the resistance, that a strong charge of electricity meets with, in the materials of the animal frame, that causes such disagreeable feelings, violent sensations, and even death, when passing through the body.

MEDICAL ELECTRICITY.

Having in some measure explained the phenomena of the electric fluid, its laws and principles of action; and pointed out the best means of defence against its unrestrained power; it now remains to be noticed, that this powerful agent, when expanded and diluted, possesses important healing powers, and is capable of being administered as a medi-

cine; and an efficient remedy for most of the disorders to which the human frame is incident. The success of its healing powers depends on the manner in which it is employed, the time it is actually used, its frequent repetition; and on other circumstances attending its immediate and subsequent effects.

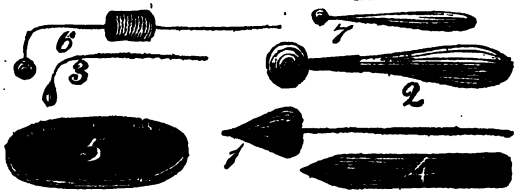
The author, from a long experience in the medical practice of electricity, is enabled to assure such persons as may be afflicted with the following diseases, that by a proper treatment, with electricity, there is great reason to expect relief.

Such as nervous head-ache; palsy, in all its varieties; rheumatism, acute and chronic; blindness; deafness; epilepsy; St. Vitus's dance; gout; cold extremities; chronic inflamation of the eyes, and sore throat; amenorrhea, or diseases peculiar to females; hysteria; hypocondrias; muscular or tendinous contraction or relaxation; tetanus, lockjaw; swellings; dropsies, general and partial; scrophulous tumours; ulcers; torpid, indurated and schirrous glands; ague and fever. In cases of suspended animation, by submersion, or a stroke of lightning, or by foul air, electricity possesses extraordinary resuscitating powers. In short, electricity may be applied to many complaints, both constitutional and local, by its general influence on the system, or by its *topical* effects on diseased parts.

The first mode of administering the electric fluid in disease, is, that of exciting it into action, by condensing or rarefying it on the system; which may be done by the patient standing, sitting or lying on an insulated bed, chair, or stool. In that situation he must be connected with the prime conductor, or insulated cushion, by a chain. If the patient is connected with the conductor, and the machine in motion, electricity will be condensed; if connected with the cushion, it will be rarefied on him. The treatment by this operation is a constitutional one; all parts of the system partake of the benefits of this active stimulus. The feelings experienced by the patient are produced more by the effects of the excitement, than from the immediate action of the fluid. The hair of the head becomes erect, the animal spirits are refreshed, and cheerfulness acquired; a genial glow is diffused over the frame, perspiration ensues, and strength is increased. In this mode nothing painful or unpleasant is felt; on the contrary, the sensations excited are altogether congenial to the feelings of the invalid.

The second mode of electrifying, is that of passing the electric current thro' the diseased parts; and here too the feelings of the patient may be made agreeable and even pleasurable. This may be done in two ways; but, it is important to choose that which is the best suited to the character and stage of the disease.

Electrical and Galvanic Apparatus.



The wooden point 1, in the sketch, which is on the end of a piece of wire, presented to the affected parts of the body, charged as before, will convey the fluid from the patient as a breeze, without subjecting him to the violence of either sparks or shocks. Or he may, while standing on the floor, receive the breeze from the point, when it is connected with the conductor, on the diseased parts, which will pass thro' him to the floor. The point in that case must be held by a glass handle. This process is known to the scientific, by the term electrical aura, or breeze. This method of applying the electric fluid, is applicable to sore eyes, inflammatory sore throat, and all other inflammations. By the effects thus produced, the energies of life are increased; the irritation of local inflammation is allayed; the nervous irritability subdued; and the disturbed feelings produced by pain, soothed into ease and repose. The dispersion or suppuration of tumours, is also obtained by the electri*cal breeze:* as well as other beneficial chan-

ges in the vital organs, and in the circulating fluids of the body.

In the paralyzed limb, or in the torpid organs, where the loss of nervous sensibility, animal heat, and muscular power is evident; the electric fluid may be given to the patient by sparks received immediately from the prime conductor, by the brass ball 2, in the sketch, held by the glass handle. Or the patient may have the fluid drawn thro' the diseased part, from him, when on the insulated stool, bed, or chair, as the case may be, by covering the diseased part with a non-conducting substance, such as dry, new flannel, from two to five thicknesses, and rubbing the part with the ball before mentioned. This method is very efficacious in palsies, both general and partial; rheumatism, acute and chronic; and in all local pains. This operation produces a sensible effect on the skin, and on the nerves and muscles of that part of the body in connection with the ball. The feelings excited by this mode of applying the electric fluid, which is termed the electric friction, resemble those produced by the flesh brush, and is attended with a sense of prickling heat. The efficacy of this stimulating process, surpasses that of embrocations, cataplasms, blisters, or manual friction. The friction by the flesh brush, is much used by gentlemen of the faculty; and indeed the principle on which it acts, is itself *founded* on the laws of electricity; it

is no more than the excitation of two imperfect electrics, which develope a portion of the electric stimulus on the surface of the body. The results, however, sought to be obtained by the brush, can be obtained with more potency by the electric friction.

The method of electrifying, by vibrations from the medical bottle, is a more important process than any other; for it can be used in every case whatever. It acts with the greatest energy on the whole system, producing an immediate perspiration. It may be used in aid of all the before-mentioned methods of electrifying. In fact, there cannot be a successful medical electrician, without a medical bottle belonging to his electrical machine.

The method of preparing one is simply by adding one or more glass tubes to the common Leyden jar; the tubes used to draw a woman's breast will answer, by cutting off the small end, and the globe at the other end; which may done by the corner of a fine file, filing it lightly around the tube, and the pieces will drop off. Then take a piece of stout wire, heat it hot enough to melt beeswax, lay the wire on the wax, and it will take up wax enough to wax the inner surface of the tube, about two inches of the middle; after the wax is uniformly spread on with the hot wire, then take a piece of tin foil, make it into a size to *fit the inner* and middle part of the tube, about *two inches* in length. It may be thrust in and

smoothly fitted to the inside, with the wire; when that is done, rub a little wax on the outside, directly opposite the inner coating, and cover the same with tin foil. Then make a hole in the cork stopple of the Leyden jar, so that the coating of the tube may touch the small wire of the jar, when it is inserted into the stopple. The tube must be put in tight, so that it may not move up and down easily; a small cork must be fitted to the lower end of the tube, and a small wire, longer than the tube, having the lower end turned to an eye, must pierce the small cork, and by it the cork must be drawn to the lower edge of the inner coating, then turn the upper end of the wire to an eye, and your tube is finished. The Leyden jar in this case needs no knob; the wire connected with the inner coating is sufficient, and will answer to give shocks by, as well as tho' the tube was not there. The Leyden jar may have two or three such tubes, and they must be of different lengths, their coating increasing in length with the tubes. The longest tube will give the strongest vibrations; all their outer coatings must be connected to the inner coating of the jars.

To give vibrations, connect the wire that projects from the top of the tube, to the prime conductor, by a short chain, and the outside of the jar must have a chain reaching to the floor. Lane's electrometer must be in its place *on the* prime conductor, and a chain

hooked to the outer part of the moving wire, that has the wooden and metal balls; the metal ball must be moved nearly up to the conductor; the patient, with his shoe off, will put his foot on the chain, that is connected to the outside of the jar, and with the contrary hand, take the chain that is connected with the electrometer. Set the machine in motion, and the patient will receive a quick succession of vibrations, which may be made stronger or weaker, according to the distance of the ball of the electrometer from the conductor; which must be no stronger than to be agreeable to the patient; and be increased as he can bear it. After the patient has received a number of vibrations in that direction, he will change hands and feet, and proceed with the same operation; then change the vibrations from hand to hand, thro' the breast, and from foot to foot. The ball of the electrometer being drawn nearer or removed farther from the conductor, materially alters the strength of the application. The ball of the director in the sketch, which has a glass handle, when connected by a chain to the electrometer, may be applied to any diseased part of the body; the vibrations are then carried thro' that part to the feet, one or both of which must be on the chain that is connected with the outside of the jar. By this arrangement, vibrations may be made a constitutional or *local* application of the electric principle.

Vibrations produce a small convulsive action, an undulating, tremulous motion, which is by no means disagreeable, not even to those in health; but is perfectly acceptable to those who need this active excitement. This method of operation has been applied by the author in numerous cases of debility, and in many of the first stages of consumption, with complete success; in such cases, the strength of the vibrations must be such as are perfectly agreeable to the patient. For amenorrhea, or female complaints, strong vibrations, and small shocks are the most efficient; in those cases, the vibrations and small shocks must be passed from the small of the back to the feet, crossing them, from the right side to the left foot, and from the left side to the right foot. The feet, in all these cases, should be connected to the chain of the outside of the jar. For deafness, the best method of applying electricity, is to pass small vibrations thro' the ear, from one to the other; for that purpose, see the wire in the sketch marked 3, the bent end of which has sealing wax melted on it, about one inch of its length, so as just to show the end, which, with the wax, must be very smooth, and small enough to enter the orifice of the ear. The wires must have glass handles—long vials with cork stopples will answer; thrust the end of the wire thro' the cork, and connect the wire by chains, one to the moving wire of the electrometer, and the

other to the outside of the jar; then place the ends that are covered with sealing wax, one in each ear; the patient can hold the wires by their glass handles, and adjust the ends to his ear himself; then set the machine in motion, and the vibrations will pass in quick succession thro' the ears; the wires may be occasionally changed from one ear to the other. The strength of the vibrations must be such as is perfectly agreeable to the patient. By persevering in this method, there is a great prospect of relief being afforded to such as are deaf. The author himself has cured a number that had been deaf for many years.

The fourth method of applying the electric principle is by shocks, which is performed by changing the connecting chain from the vibration tube, to the knob or wire of the jar. The old method of giving electricity, was by strong shocks from two gallon jars; but such strong shocks are generally found to retard the cure, although there have been instances of relief being afforded by such strong shocks; yet still it is found, that relief may be obtained with more certainty by a moderate mode of electrifying. Moderate shocks are of advantage in cases of great local insensibility, in which a strong action is necessary to rouse the dormant powers; and in cases of induration of tumours, where dispersion or suppuration is required, it is productive of salutary effects; and in cases of recent derange-

ment, great relief has been obtained by strong shocks being passed from the head to the feet: four such cases of derangement have come within the practice of the author, where a perfect restoration to reason was effected in a very short time. In cases of derangement, the patient had better be put into a straight jacket, or he may do great damage to the machine. In ague and fever, electricity administered by light shocks, during the cold fit, will greatly assist in its cure.

As there are cases, which some of the faculty have witnessed, where it was difficult to determine whether life was extinct, or only suspended; and in those cases of somnolency, where a strong disposition to sleep was manifested. In all such doubtful cases, the author would suggest, and earnestly recommend, that electricity should be tried, and persisted in with energy. The method of its application, in all such cases, which he would recommend, would be by moderate shocks, increasing their strength as may be found necessary. The shocks ought to be passed through the region of the heart, to the opposite side; from hand to hand, through the breast; from the hands to the feet, crossing them; and from the back of the neck, also, to the feet. The body may be insulated, and sparks drawn from around the region of the heart and breast; and electric friction should also be used around the breast and heart. Electrici-

ty, from its stimulating and exciting powers, when other means have failed, might come like the good Samaratan, resuscitate and rouse the dormant powers of vitality. But when, during the operation, electricity is seen passing over the surface of the body, or does not move it, the case is a hopeless one; and from the opportunities the author has had of experimenting in such cases, if such should be the effect of the electric excitement, he should desist from any further trial, and consider that vitality had ceased.

Those who are called on to administer electricity in diseases, ought never to commence with strong shocks, even if they are necessary, more particularly to females. Commence with vibrations, and increase the strength of them, moderately; and persevere in, at least daily applications, changing the mode, until you find that which appears to afford the most relief; by such means, you will often succeed in relieving many, that were deemed incurable.

GALVANISM.

The discovery of the principle termed galvanism, originated with Mrs. Galvani, lady of Lewis Galvani, of the city of Bologna in Italy. Some time in the year 1789, there having been prepared a number of the hind quarters of frogs, for soup, they were laying on the table of the electrical machine, in his laboratory;

on receiving electrical sparks from the conductor, a knife laying near the frogs; instantly the muscles of their limbs were agitated with convulsions. Madame Galvani, a lady of quick understanding and scientific turn, being present, was struck with the phenomenon, and immediately informed her husband, who came and repeated the experiment. This accidental discovery has immortalized his name, by philosophers giving this newly discovered principle the name of Galvanism. Mr. Alexander Volta, who was also an Italian, has likewise immortalized his name, by the improvements and additions he has made to the galvanic apparatus. Since which, many other philosophers have improved on the apparatus, Dr. Wallaston, Sir Humphrey Davy, Mr. Children, of Europe, and Dr. Robert Hare,* of Philadelphia. The power that the galvanic principle possesses, of decomposing various bodies, has been of the utmost importance in science. Its power of deflagrating the most infusible metals is evident, from the instantaneous fusion of a tenpenny nail, which, on being made a part of the circuit of a galvanic arc, of a powerful galvanic battery, instantly takes fire with a most brilliant light, and falls in globules of melted iron. This, and many other extraordinary experiments, may be made with a large and powerful galvanic battery.

*Inventor of the compound blow pipe

Directions for the construction of Medical Galvanic Troughs.

The above sketch represents a galvanic trough, constructed on the plan of Dr. Hare's deflagrator, and improved by the author for medical purposes. It consists of thirty zinc plates, 2 by 3 inches square; each of which is surrounded by a copper case, which is so large, that the zinc plate may be a large 8th of an inch clear from touching the copper. The zinc plates may be either cast in a mould, or cut out of sheet zinc; but the cast plates are the best, and will last much longer. The copper cases are cut out of thin sheet copper, formed on a mould, and soldered with soft solder; they must be open on the top and bottom, and may be made by a tinner. The zinc plates are kept separate from the copper in which they are suspended, by pieces of wood or cork fitted to the sides of them. The plates, with their copper cases, are to be fitted to a bar, made in the following manner. *First,* prepare two pieces of hard wood, one

inch square, and about three feet long; make a groove on one side, a large 8th of an inch deep, and about one-third of its width, then tenant the two pieces together, the grooves inside, three-fourths of an inch apart, by a tenant in the middle and at each end; then prepare another piece of the same kind of wood, and rabbit it to fit the grooves on the inside of the bar, then saw it up into pieces of an inch long, as square as possible, and put them into the grooves, leaving an inch or two at each end empty, for the pieces to move in. As these pieces will not want to be taken out, the end tenants may be permanently fitted in by rivets or screws. The ears to suspend the copper cases and zinc plates by, must be as wide as the space to receive them is in the bar; and the ears for the zinc plates must be one inch and a half long, the ears for the copper must be two and a quarter inches long. The copper ears must be divided into three parts, the part nearest to the case a half inch, the next three-quarters, and the end part one inch; and then bent accurately at right angles, as in the annexed sketch, which shews the ends, as they go into the bar, connected with the zinc plates. The ear of one zinc plate of one case, connected with the ear of the next copper case,

and so on alternately, until the whole bar is complete. The whole of the plates are to be forced together by a wedge driven between the outer tenants and the moveable pieces in the bar. The copper ears, where they are brought in contact with the zinc, must be scraped very clean and bright, before they are put together. The whole of this work must be done in a workmanlike manner; and when so done, it is a better method of suspending the plates to the bars, than any before thought of; they are easily taken apart, and cannot be put together wrong.

The troughs may be made of any wood, white pine will do; They must be a half inch deeper and wider than the copper cases; the length must be according to the number of series, and the distance they are apart. The partitions must be let in by a groove, and permanently fitted in with hot beeswax. And when the troughs are finished, very hot beeswax must be turned into each cell, and immediately turned out, before the wax gets cold; their outsides may be painted. It is necessary to have a trough without partitions, for water, to immerse the plates in after they have been used, to wash off the liquor, to prevent them from oxidating too fast. On each end of the bar, a piece of copper must be connected with the end plates, and bent flat on the *bar;* and named Z. for the zinc end, and C. *for the* copper end, to connect the wires, tubes,

The apparatus for applying the galvanic influence in diseases, is represented in the sketch headed "*Electrical and Galvanic Apparatus.*" Its parts consist of a copper shoe, (a piece of sheet lead or pewter plate will answer, if it is larger than the foot); two copper tubes, pointed at one end, six inches long, and 3-4 inch diameter, one of which is represented in the sketch, fig. 4; two stout brass wires, 18 inches long, bent at one end, and a small shot, of a size to fit the orifice of the ear, permanently fixed to that end—the wire must be run through a cork or piece of round wood, which is to answer for a handle—it is represented in the sketch as fig. 6. Two stout brass wires, about two and a half or three feet long, are also necessary, and they too, must have cork or wooden handles: several pieces of tea chest lead, of various sizes, are also wanted.

The copper shoe is to put the naked foot in, when galvanism is to be passed in that direction. The tubes are to be clasped in the hands, and their points are to touch the coppers at the ends of the bars, when galvanism is to be passed through the arms and breast. The bent wires with the shot on the ends, are to convey galvanism thro' the ears for deafness. The long wires are to connect the diseased parts of the body when covered with the tea chest lead, to the copper on the ends of the bars.

A strong solution of salt in water, is a good liquor to immerse the plates in for medical use; the strength of the trough may be increased by the addition of a wine glass full of muriatic acid; or 20 parts of water, to one of muriatic acid, may be used instead of salt water.

In directing for the medical application of galvanism, it must be observed, that in all cases it must be applied to the naked skin, and that moistened with warm salt water; and the shoe, when used, must have a small quantity of warm salt water in it. When the tubes are used, the hands must be wet with the same, and the pieces of lead must also be kept wet, while applied to the skin, and may be bound on the diseased part with tape or garters. To apply the galvanic influence in dispepsia—having first filled your trough with the liquor to a proper depth so as just to cover the plates when immersed; proceed to prepare your patient, by putting on the leads, one on the stomach, about as large as your hand, and another opposite, on the back, both of which must be occasionally moved round the sides of the body; then immerse the plates, and connect one of the long wires to the lead on the stomach, and the C. end of the bar; and the other long wire to the lead on the back, and keep touching the copper on the Z. end of the bar. If it is too strong at that distance, approach the C. end, and touch the ears of the plates, as they appear on the top of the bar;

by that means you can regulate the strength of the plates to the patient's feelings, which must always be made agreeable. For the application of galvanism in rheumatism in the arms and shoulders, take the copper tubes in your wet hands, and touch the points to the coppers at the extremities of the bar, keeping the tube on the C. end, and occasionally touching the Z. end with the other. In all applications of the galvanic influence around the body, or for local pains, the lead on the diseased part must always be connected with the C. end of the bar; and whenever the foot is in the shoe, or on the leads, that must be connected with the Z. end. For complaints of the spleen or liver, the leads about the size of the hand must be applied directly over the diseased parts, and the galvanic influence may be occasionally led to the foot, or around the back. For asthma, a large piece of lead must be applied to the breast, and around the back; and galvanism administered moderately, twice a day, for a number of times. All applications ought to be continued for at least 10 minutes, and in many cases a much longer time. For deafness, the patient moistens his ears with warm salt water, takes the crooked wires with the shot on the bent ends, inserts the shot ends into the orifices of the ears, and holds them by their cork or wooden handles, (for he must not touch the wires with his *hands*—if he should, part of the galvanism

would pass in that direction) the end of the wire that is in the deafest ear, on the C. end of the bar; and touch the end of the other wire along on the ears of the plates, so far as to make the sensation agreeable; and continue the operation for about 15 minutes. When both ears are afflicted alike, the ends of the wires may be occasionally changed from the C. to the Z. end. In all other applications of galvanism, the same order in the arrangement must be observed.

Galvanism, as possessing important curative or healing powers, is but little known: having heretofore been considered as wholly resulting from electrical phenomena, its powers had only been tested in cases where electricity was considered useful. But now the phenomena of galvanism is, both by the European and American philosophers, considered as resulting from a combination of electricity, caloric (or the principle of fire), and light. Its powers as a medicine, is now rapidly developing; it has been administered with extraordinary success in asthma Dyspepsia, chronic hepatitis, dropsy, constipation or costiveness. And in that most distressing complaint, colick pictonum, or what is called the painters' colick, by reason of their employment in preparations of lead, which often induces palsy in the hands; and in cases where *mercury has* been used in vain, the galvanic *treatment has* completely succeeded. One of

the greatest medical electricians of Europe, M. Le Baume, speaking of the curative power of galvanism, says, that he "feels justified in asserting, that the whole Materia Medica may be searched in vain, to find such a panacea as the galvanic influence, in torpor of the stomach, liver, and bowels."

On the conducting power of Water.

It has been supposed by some persons, that they would be protected from the effects of lightning, by their clothes being wet in a thunder storm. To satisfy ourselves whether such is a fact, let us try the following experiments, keeping in view a law that evidently governs the action of the electric principle. That is, when electricity is passing from its condensed to its rarefied state, it always follows the best conductor, and the nearest course. We will now proceed with the experiment; charge a Leyden jar with the electric fluid, having first prepared a large bowl nearly full of water; then dip the end of a chain that is connected with the outside of the jar, into the water near the edge of the bowl; and another chain dipped into the water directly opposite the one already in, and take the other end of the chain into your hand. Now let another person dip a finger of each hand into the water near the chains, but not to touch them; while his fingers are in that situation, you must touch the

end of the chain you have in your hand, to the knob of the jar, and the person whose fingers are in the water, will receive the charge of electricity that is in the jar. Now if the water only possessed the same conducting power as our bodies, we could not possibly feel the charge of the jar; for it was much nearer for the electricity to pass through the water, than to pass 4 or 5 feet through our hands, arms and breast, in its passage to its rarefied state. This experiment is sufficient to satisfy us, what safety we may expect from the conducting power of water!!

Cement for Electric Machines.

(a) Take 2 parts of rosin, one of beeswax, and one of Spanish brown; these ingredients must be melted and mixed over a slow fire, in any vessel, and kept for use.

Varnish for Electric Machines.

(b) (c) & *(e)* If red be wanted, dissolve the best red sealing wax, in highly rectified spirit of wine or alcohol. If black be wanted, take black sealing wax; the proportion may be two ounces of sealing wax to half a pint of wine.

For common spirit varnish, take two ounces of shellac, to half pint of wine, and a *piece of rosin* about as big as a pigeon's egg;

after the ingredients are put into a bottle, it must be kept in a warm place and frequently shaken—may be strained through a flannel, and kept well corked.

(d) Coaxing is a cant term for those machines that will not work without being warmed, either by the fire or sun-shine.

Amalgam, for the excitation of Elecirical Machines.

Take 3 parts quicksilver, one part of zinc, and one part of block tin. First melt the zinc in an iron ladle; when the zinc is melted, put in the tin; at the same time, have the quicksilver in a common tea cup, on some hot ashes, and when hot, turn into the quicksilver the zinc and tin; keep stirring it with a wooden stick till it is cold, and keep it for use in a common pill box.

Directions for restoring Suspended Animation.

1.—*What thou doest—Do quickly.*

2.—Humane persons *are earnestly requested* to prevent the *drowned being rolled on casks, hung by the legs,* or any violent means to be employed.

3.—Convey carefully the body, with the *head raised,* to the nearest house that will re-

ceive it, on a door, wide board, or n
and send to the nearest medical assist

4.—Strip the body; clean the m
nostrils.

5.—Young children to be put betw
persons in a warm bed.

6.—An adult—Lay the unfortunate
on a bed, and in cold weather, near

7.—In summer expose the body to
of the sun; and AIR should be freely a

8.—The body to be gently rubb
flannel, sprinkled with spirits, flour of
&c. salt never to be employed—also
warming pan properly covered, may b
ly moved over the back and spine.

9.—To restore breathing introd
pipe of a bellows (when no apparat
hand) into *one* nostril; the *other*,
mouth being closed. *inflate the lungs*,
breast be a little raised; the mouth a
trils must then be let free, and the
gently pressed wi n the hand: THIS
to be repeated till the return of life.

10.—The breast to be fomented
spirits, warm bricks or tiles covered,
be applied to the soles of the feet, an
of the hands.

11.—Electricity to be early emplo
ther by the medical assistants, or oth
cious practitioners, as directed in pag
galvanism, as is most convenient.

INTENSE COLD.

Rub the body with snow, ice or cold water. Restore warmth by slow degrees; if life does not soon return, the process of the drowned must be employed.

SUSPENSION BY THE CORD.

1.—A few ounces of blood taken from the jugular vein: cupping glasses applied to the head and neck; leeches also to the temples.

2.—The other methods of treatment, the same as recommended for the apparently drowned.

NOXIOUS VAPOURS.

Cold water to be repeatedly thrown upon the face, &c. drying the body by intervals. If the body feels cold, employ gradual warmth, and the plans for restoring the drowned.

RETURNING LIFE.

The resuscitative process should be applied in a more gentle and cautious manner. Stimulants, &c. on the return of animation, are now only to be employed with a view to assist and strengthen languid vitality.

Dr Armstrong is descriptive and illustrative of our sentiment on this interesting subject:

——————"While the vital fire
"Burns feebly, heap not the green fuel on;
"But prudently foment the wandering spark,
"With what the soonest feels its kindred touch;
"Be frugal e'n of that, a little give
"At first, that kindled, add a little more,
"Till by deliberate nourishing, the flame
"Revived, with all its wonted vigor glows."

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